## Project Introduction

Higher-order Reynolds-averaged Navier-Stokes (RANS) models are developed to overcome the shortcomings of second-moment RANS models in predicting separated flows. These differential transport models hold promise in predicting reversal of turbulent transport typical in adverse pressure gradient flows. Third- and fourth-order moment transport models are developed and used to simulate canonical boundary layer and two-dimensional separated flows.

Existing RANS turbulence models over-predict the extent of separation, making them unfit for off-design aerodynamic studies. Second-moment closures (SMC) have failed to improve flow separation predictions over simpler two-equation models. Failure may be in part due to inability of algebraic models for turbulent transport to predict transport reversal typical in decelerating flows. To overcome this shortcoming, we represent the turbulent transport term using a differential model. The differential transport model leads to closing the RANS system equations either at the fourth- or fifth-order moment level. Models are constructed based on a-priori studies on existing moment budget term models. The system of about 10-14 turbulence equations are solved iteratively.

## Anticipated Benefits

Addresses one of the technical challenges outlined in the Transformative tools and technologies project of NASA, to reduce separation prediction error by 40% by 09/2017

Improvements in vehicle external aerodynamics CFD predictions

Higher-order RANS turbulence models for separated flows

## Table of Contents

# Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Center / Facility:**

Langley Research Center (LaRC)
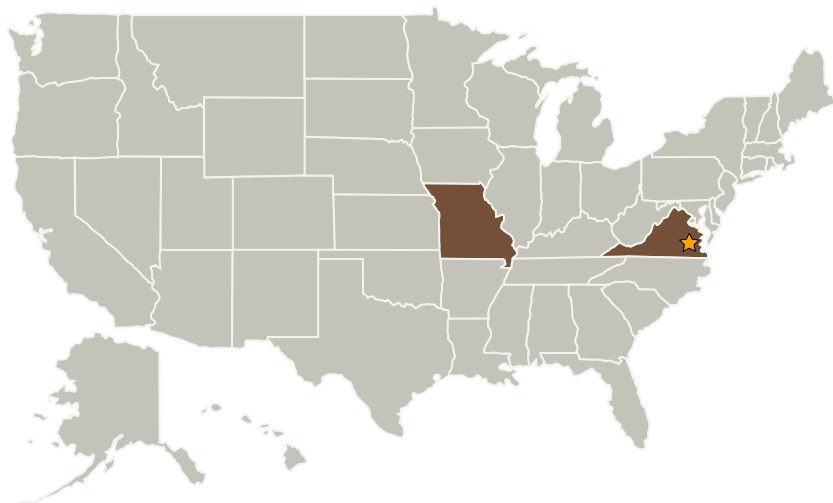
**Responsible Program:**

Center Innovation Fund: LaRC CIF

## Primary U.S. Work Locations and Key Partners



| Organizations Performing Work | Role | Type | Location |
|---|---|---|---|
| ⭐Langley Research Center(LaRC) | Lead Organization | NASA Center | Hampton, Virginia |

| Primary U.S. Work Locations | |
|---|---|
| Missouri | Virginia |

## Project Management

**Program Director:**
Michael R Lapointe

**Program Manager:**
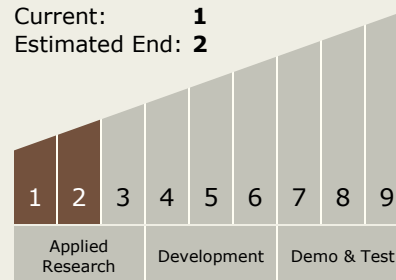Julie A Williams-byrd

**Principal Investigator:**
Elbert Jeyapaul

**Co-Investigator:**
Christopher L Rumsey

## Technology Maturity (TRL)

Start: **1**
Current: **1**
Estimated End: **2**



## Technology Areas

**Primary:**

- TX09 Entry, Descent, and Landing
  - TX09.4 Vehicle Systems
    - TX09.4.5 Modeling and Simulation for EDL